Copper Diffusion at the Copper/Silicon Interfaces: Is it really that big a problem?

Yuelin Xiong[1] and Sebastian Bonilla[1]

[1]Department of Materials, University of Oxford, UK

Department of Materials
Electronic and Interface Materials Laboratory
http://interface.materials.ox.ax.uk

Introduction

Copper metallisation as silver alternative:

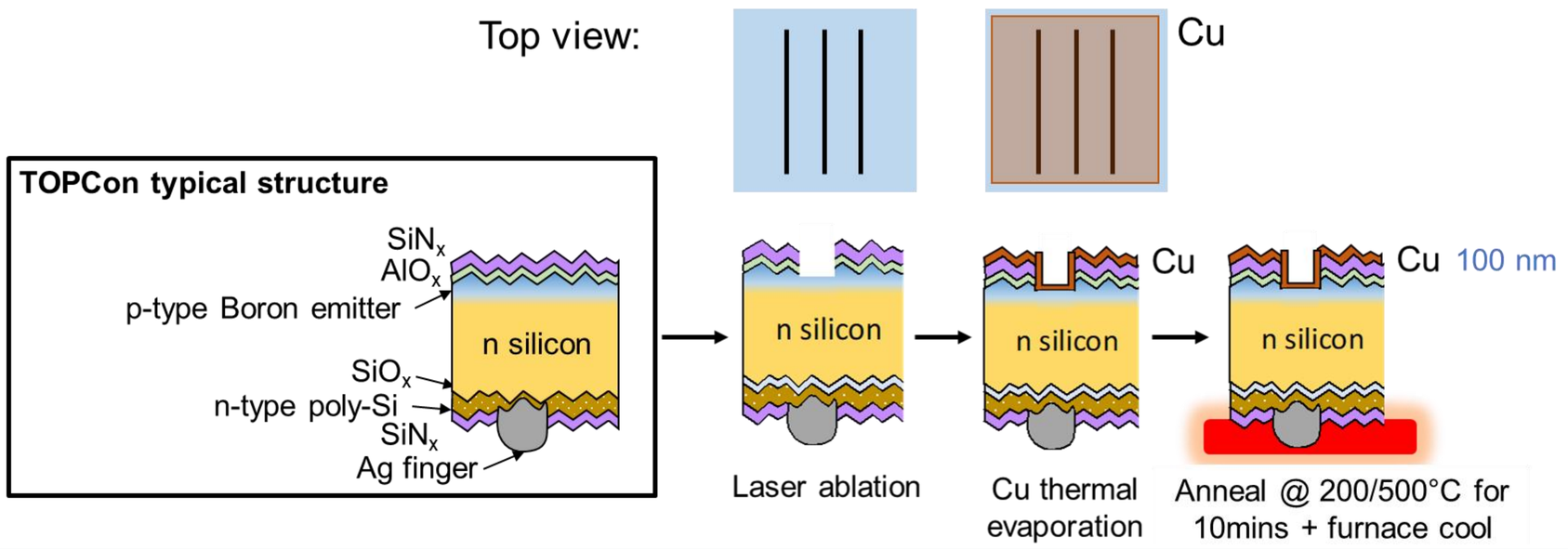
- ~80 times cheaper, ~800 times more abundant than Ag
- high conductivity → lower finger resistance
- thin finger width → less shading loss

- Cu has high diffusivity in Si → Highly active deep-level recombination centre → Degrades cell performance [1].

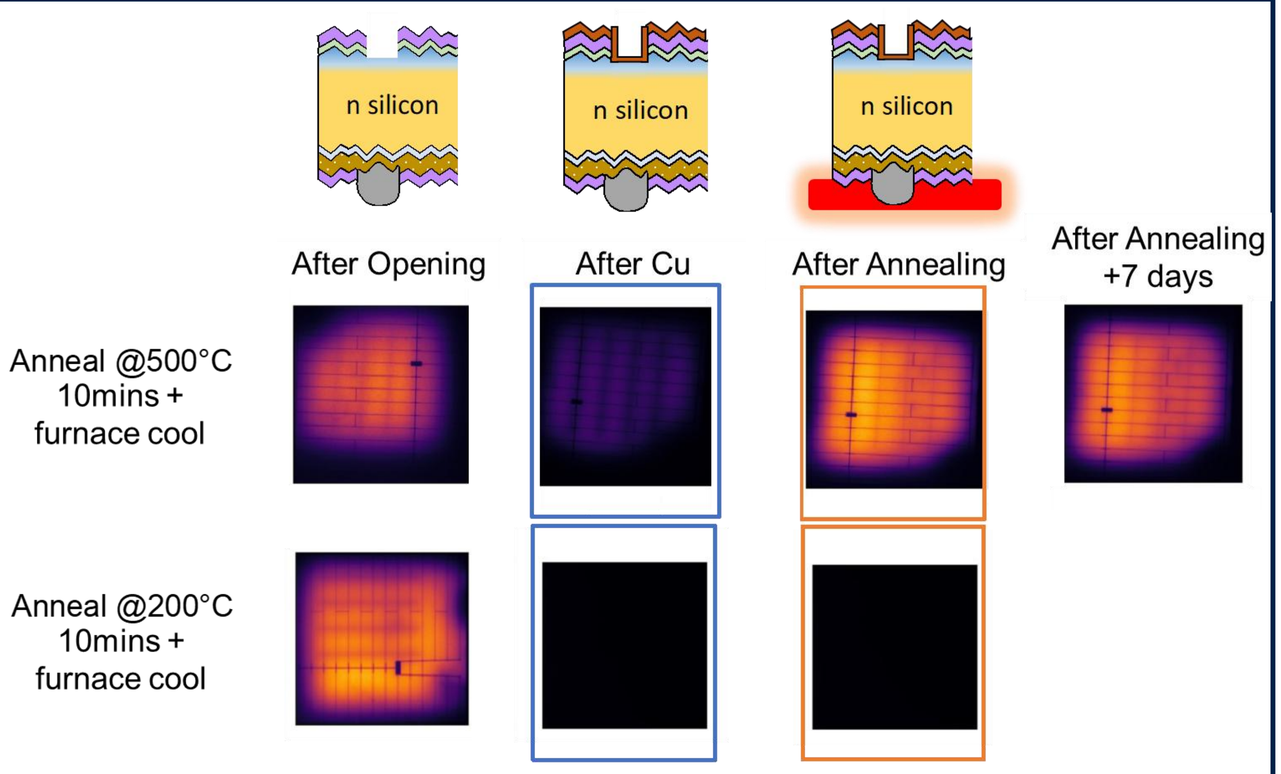
But is it really that big a problem?

Experimental Setup

- UV picosecond laser openings on the AlO_x/SiN_x stack.
- Thermal evaporation of Cu on the front side.
- Heat treatment at 200 / 500 °C
- Detection of Cu diffusion via degradation in PL intensity.

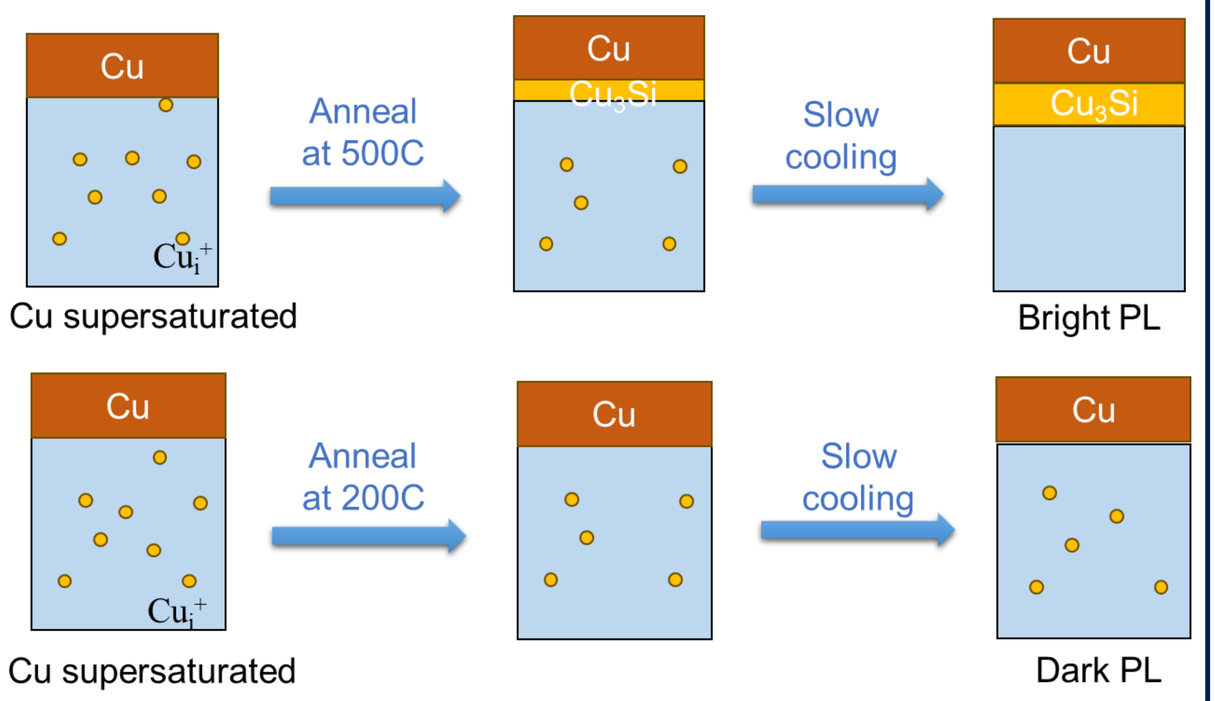


Annealing Cu/Si Contact at Different Temperatures



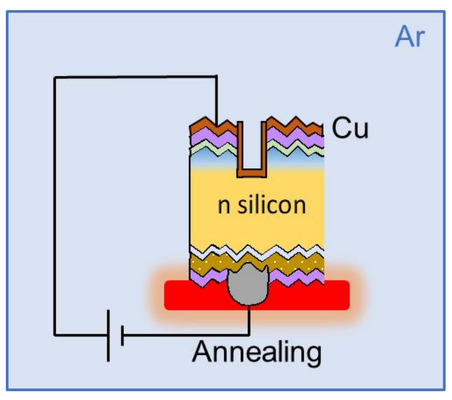
- **Post-Cu Deposition**: PL drops in Cu/Si contact regions due to defect-induced recombination.
- **500 °C Anneal** → PL recovers, stable for 7 days → Defect recovery.
- **200 °C Anneal** → PL remains dark → Defect remains in Si bulk.

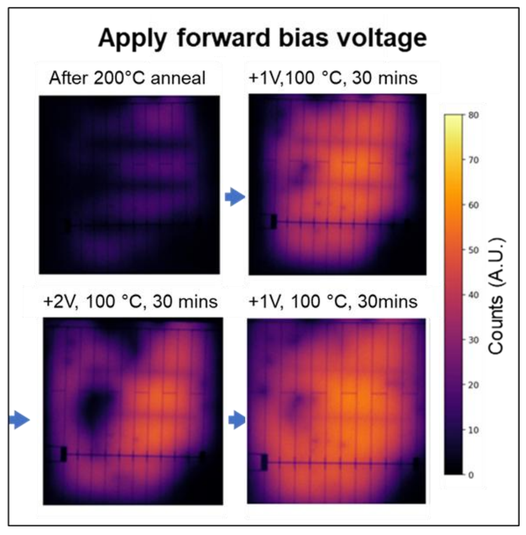
Hypothesis - Gettering



- **Gettering:** Removes impurities by trapping them in specific regions/layers to improve material properties.
- **500 °C Anneal** → Cu-silicide/Cu colonies form → Cu diffuses towards gettering sites → Fewer bulk defects.
- **200 °C Anneal** → No Cu-silicide/Cu colonies → Cu remains in Si bulk → No gettering.

Forward Bias Stress and Temperature





- Bias & temperature recover Cu-induced defects.
- Could be driven by chemical potential gradient.

Conclusions

- Cu-induced degradation is reversible after a 500 °C anneal, restoring effective carrier lifetime.
- 200 °C anneal shows no recovery.
- Copper remains a promising alternative for solar cell metallisation.

[1] A. A. Istratov, et al, 'Intrinsic Diffusion Coefficient of Interstitial Copper in Silicon', Phys. Rev. Lett..

yuelin.xiong@materials.ox.ac.uk

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